RHEUMATOID ARTHRITIS; ITS CAUSATION AND TREATMENT*

SIR HUMPHRY ROLLESTON, BART., K.C.B., M.D.

Regius Professor of Physic in the University of Cambridge; President of the Royal College of Physicians of London

THE subject of what is commonly called rheumatoid arthritis is especially appropriate at Bath, with its long historical association with the treatment of joint disease, its special hospitals, and its wealth of clinical material.

For this discussion the designation "rheumatoid arthritis" may be taken to cover the group of chronic joint affections of uncertain nature, but it has been considered convenient to leave aside the condition of advanced osteo-arthritis, especially of the hip in old people, though it must be admitted that such a condition may be the outcome of the rheumatoid arthritis. Fibrositis, which Stockman says always precedes, and in any case is much the same as rheumatoid arthritis, except that, like panniculitis, it concerns connective tissues other than those in or about the joints, may, in order to reduce the already extensive scope of the subject, also be omitted. Regarded in this somewhat arbitrary fashion rheumatoid arthritis is, like splenic anæmia, a repository for syndromes not proved to be specific. The subject is so enormous that it is obviously impossible to touch on all its numerous aspects.

ETIOLOGY

The present conception of the disease is that it is infective, but it may be well to consider if this is absolutely certain.

The Question of Disordered Metabolism

In 1907, while admitting that treatment of focal infections is sometimes followed by amelioration or even cure of the affected joints, Sir Archibald Garrod—son of Sir Alfred, who in 1858 introduced the name rheumatoid arthritis—doubted if these cases are really examples of the specific disease rheumatoid arthritis, adding the cautious proviso, "assuming that such a specific disease exists." In 1923 he was of much the same opinion in opening a discussion at the Royal Society of Medicine, at which Cassidy expressed his firm conviction that the importance of infection had been greatly exaggerated and, while granting the existence of a large group of cases of chronic infective arthritis, believed that there was also a genuine rheumatoid arthritis—a somewhat uncommon disease probably due to disordered metabolism. The question, then, is: Are all forms of chronic arthritis, with the exclusion of the nervous arthropathies, as in tabes and syringomyelia, gout, hæmophilic and possibly psoriatic arthropathy (Garrod and Evans), to be regarded as due to infections with various micro-organisms of a low virulence, or ought an open mind to be still maintained as to the existence of cases independent of microbic infection from the start and due primarily to some disorder of metabolism analogous to gout as commonly accepted?

What evidence is there that disordered metabolism is the sole cause of rheumatoid arthritis or of a certain group of cases in this category? Hereditary disposition to arthritis is not a very strong argument, and what is much the same though a broader conception, the "arthritic diathesis" is not a very satisfactory conception; for they both might be regarded as, in other words, an inborn want of resistance to infection. Joint changes have been described in a few rare cases of that "inborn error of metabolism" alkaptonuria and ochronosis. According to Pemberton (1921), the basal metabolism is lowered, and the sugar tolerance is lowered in rheumatoid arthritis; but it might justly be argued that this really depends on infection as it returned to normal abruptly on removal of the focal infection. From his point of view, then, the metabolic defect appears to be limited to the carbohydrates, and might be regarded as, in common with the arthritis, due to infection.

It is impossible to deny that an inherent disorder of metabolism might favour an infective or toxic arthritis by diminishing the resistance, and that gouty deposits are found in chronic rheu-

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matoid joints, though they may be secondary rather than primary. On the other hand, it is known that an infection may, by inducing pancreatic disorder, lead to a more or less permanent lowering of sugar tolerance; Pemberton (1925) considers that such a permanent lowering of sugar tolerance accounts for the disappointing results of removal of definite foci. It may therefore be logically argued that a lowered sugar tolerance alone may also cause rheumatoid arthritis. But rheumatoid arthritis is not a feature of diabetes mellitus, even though infections are prone to occur; so that as regards disorder of carbohydrate metabolism as a primary factor in the causation of rheumatoid arthritis the positive evidence is very weak. Although infection may so affect the endocrine glands as to modify metabolism and thus favour joint changes, this is very different from postulating a primary error of metabolism independent of infection.

G. Draper (1920) argues that chronic arthritis represents a very profound constitutional disturbance in forces analogous to those concerned in acromegaly and thyroid insufficiency, and chronic arthritis due to thyroid insufficiency (Léopold-Lévi and Rothschild; Sergent) and to pluriglandular inadequacy, especially ovarian (Umber), has been described; but it may be objected that chronic infection is really the underlying factor of both the endocrine and the arthritic disorder. The endocrine element in arthritis has recently been discussed by H. K. Thompson, who divides the cases of arthritis into (*a*) isotrophic or chronic infective arthritis, due to, and curable by removal of, the infective focus, and differing structually from the two following forms—(*b*) atrophic or rheumatoid arthritis occurring in individuals of the slender "carnivorous" type of Goldthwaite and Bryant, and associated with, but he does not say definitely due to, some evidence of endocrine dysfunction, often hyperthyroidism, (*c*) the hypertrophic, or osteo-arthritic of our nomenclature, attacking the "herbivorous" type of Bryant and Goldthwaite, with low metabolic rate, benefited by thyroid medication, and showing evidence of hypothyroidism. It will at once be obvious that as osteoarthritis and hypothyroidism are both common in advanced life, their coincidence does not prove that the joint lesion is secondary to the thyroid disorder. Thompson does not prove or, indeed, dogmatically claim more than that "certain types of arthritis are not necessarily disease entities, but may be symptoms of, or coincident with, an endocrine dysfunction." Correspondence between the geographical distribution of endemic goitre and rheumatoid arthritis (McCarrison) and the disposing influence of hypothyroidism, which has been regarded as identical with the arthritic diathesis (L. J. Llewellyn, 1925), might be explained by the view that they are both results of an underlying endemic infection.

Infective Origin

The effects of oral sepsis, largely due to W. Hunter's advocacy and more recently to Billing's book and Willcox's papers, are now well known, and its association with arthritis is fully recognized; but this advance has occurred well within the lifetime of many of us, and the importance attached to it has progressively increased. The relative responsibility of the teeth and the tonsils has been variously estimated; the teeth and gums have been incriminated for 90 per cent. of the cases (Beddard; Willcox, 1923); Lillie and Lyons, from a series of 200 consecutive cases of tonsillectomy for arthritis, possibly a one-sided experience, considered the tonsils responsible for 79 per cent. of the arthritic cases. Pemberton (1921), on the basis of 400 cases, gives percentages of 52 for the tonsils and 33.5 for the teeth. Possibly they are about equally responsible, and they certainly may both be diseased in the same patient; but, as the tonsillar and peritonsillar infection may be secondary to the dental, the latter should perhaps be given the first place. Adenoids should of course be considered in the same category as the tonsils. With regard to the teeth, a distinction has rightly been drawn between (1) pyorrhœa, in which the infective agents are discharged into the alimentary tract and are therefore prone to set up secondary foci in the tonsils, and, if there is achlorhydria, in the gall bladder, intestines and appendix, but are not so likely to pass into the general circulation and reach the joints as in (2) apical infection of the teeth, which may occur in teeth superficially healthy and so require skiagraphic assistance for their detection; here, being in a closed space, absorption by the blood is more likely to take place. A secondary focus in the maxillary antrum may be due to local extension of dental

infection, and it is important to eliminate both foci. It would be interesting to have statistics showing what proportion of cases of rheumatoid arthritis are associated, on the one hand with pyorrhœa alone and on the other hand with the apical infection of the teeth only; I am informed that it should not be difficult to obtain cases with pyorrhœa but without any trace of apical infection.

It is perhaps still necessary to emphasize also the importance of the accessory nasal sinuses as sites of infection, which may be responsible for arthritis; sinusitic infection may be secondary to oral, dental, or pharyngeal lesions; or, conversely it may be primary and give rise to them. It seems probable that unless the exit of discharge, purulent or otherwise, is obstructed, sinusitis is, like pyorrhœa alveolaris, more likely to cause gastroenteritis and secondary foci in the gall bladder and vermiform appendix than systemic and arthritic infection. Cases of sinusitis responsible for arthritis may be latent and escape attention, and Dr. P. Watson-Williams believes that it is the slighter, rather than the profuse purulent forms of sinusitis that cause arthritis, because they are not accompanied by a polymorphonuclear leucocytosis which protects against the effects of absorption. For the detection of infection of the accessory sinuses transillumination and skiagraphy may be misleading and are not so satisfactory as puncture.

The activity of intestinal bacteria largely depends on the presence or absence of hydrochloric acid in the gastric contents. Achylia gastrica has been described in rheumatoid arthritis by Knud Faber, Woodwark, and Mackenzie Wallis and Hurst. Coates and Gordon, adopting Hurst's explanation of the relation of subacute combined degeneration of the spinal cord to Addisonian (pernicious) anæmia, suggest that in rheumatoid arthritis, achylia gastrica allows the bacterial production of a toxin with a special predilection for the synovial membranes.

Intestinal auto-intoxication has been urged, especially by Sir Arbuthnot Lane, as a cause of chronic arthritis. Pemberton (1914), from numerous laboratory investigations, found that protein putrefaction is not a factor, but Mutch has developed Lane's conception on bacteriological lines. In 1915 he found intestinal infection with staphylococci in Still's disease; later he insisted on a long-chained streptococcus as a pathogenic intestinal organism, and the observation, made in 1921 by N. and J. Mutch, of its characteristic glycophile character or avidity for sugar, is of great interest in connection with Pemberton's successful results in restricting the carbohydrate intake of chronic rheumatoid patients. Mutch, like Lane, insists on the frequency of masked stasis and hidden infection in the intestinal tract of patients with rheumatoid arthritis. Beddard, however, considers that in the absence of signs, such as attacks of diarrhœa, pointing to infection of the intestinal mucosa, this is improbable. Primary infections of the colon, such as dysentery, have been considered to be rarely responsible for rheumatoid arthritis in this country, the great majority of colonic infections being secondary to oral infections. On general principles intestinal infection should be restrained by the antitoxic function of the liver from producing secondary changes in the joints, though it is possible that in certain cases bacteria might pass via the thoracic duct into the general circulation and so escape the hepatic filter. It would be interesting to know the results of tests for hepatic efficiency, such as Rosenthal's modification of the phenoltetrachlorphthalein test, in cases of severe chronic infective arthritis.

Infections of the genito-urinary tract, excluding those of gonococcic origin, do not play a prominent part in the production of arthritis, but it may occur in *Bacillus coli* infections of the urinary tract, in infections of the prostate and vesiculæ seminales; and streptococci from chronic endocervicitis have been stated to be specially prone to cause arthritis (Moench). Attention was called by T. McCrae to prostatic infections as a cause of arthritis, especially of the spine, and among 100 cases of chronic arthritis von Lackum found that in thirty-two the only primary focus was in the prostate. Infection of the vesiculæ seminales may extend from the prostate, and though often gonococcic or tuberculous, may be due to other micro-organisms.

Infections of the respiratory system have attracted comparatively little attention as a cause of chronic arthritis; Pierre Marie's chronic pulmonary osteo-arthropathy is, of course, a well marked example. Mention should be made of Poncet and Leriche's view, apparently widely accepted in France, that the commonest form of

chronic infective arthritis is that due to the toxins of a distant tuberculous focus acting on the joints; 50 per cent. at least of the cases ordinarily met with are thus explained (Mouriquand and Michel), the joint affection being, in in fact, analogous to a tuberculide of the skin. This conception of the widespread influence of tuberculosis has received little recognition and no support in this country, possibly because its pathogeny is still uncertain—namely, whether it is entirely toxic, the joints never being infected—and also because it is so different from ordinary tuberculous arthritis. H. Platt could not find any conclusive evidence that it was a pathological or clinical entity. Probably many would agree with Byfield's dictum that Poncet's disease is merely chronic arthritis in a person with tuberculosis; but even then it should be borne in mind that the joint lesion might be modified by the presence of a tuberculous focus elsewhere; further, the long debated and now established syphilitic nature of tabes dorsalis should warn us to keep an open mind in the relation of tuberculosis to chronic arthritis of doubtful origin.

Skin infections, such as boils, may be responsible for rheumatoid arthritis, and Stockman has seen it in general dermatitis and lupus erythematosus; but whether or not chronic arthritis may follow impetigo, as nephritis has done (Guiard; J. Phillips), is an interesting point. The etiology of psoriatic arthritis has given rise to some discussion: Garrod and Evans remark that the rapid recovery of the joints "when the psoriasis clears up is unlike anything seen in cases ordinarily classed under the name rheumatoid arthritis and is only approached in severe cases of dysentery." This is perhaps evidence of the success of removal of a primary focus rather than of their contention that neither lesion is a mere complication of the other.

Consideration of Criticisms of the Infective Theory of Rheumatoid Arthritis

It has naturally been urged against the focal infection theory of rheumatoid arthritis that extensive infection, especially oral, may exist for a long time without the sequence of rheumatoid arthritis or other systemic lesions; and indeed it has been stated, probably with considerable truth, that few persons of mature years are entirely free from chronic septic foci. Further, it has been insisted that in many cases of rheumatoid arthritis careful search fails to reveal a septic focus. In considering why very definite focal infection often fails to cause joint lesions, the constitution of the individual, his powers of resistance, must be taken into account; the moral, now well recognized in the case of tuberculosis, that the soil (the local conditions of the joints) as well as the seed (the infective agent) is an important factor in determining whether or not disease results, should be more extensively applied in rheumatoid arthritis. Cases certainly occur in which a focal infection exists for years before the onset of arthritic phenomena, which may then run a rapidly progressive course, crippling the patient in a few years. Something, perhaps an attack of influenza, has broken down the individual's immunity and powers of resistance, among which the bactericidal power of the gastric hydrochloric acid must be taken into account, or in a more marked degree has rendered him sensitive to microorganisms or to foreign bacterial proteins to which he was previously immune. Another example of this acquired susceptibility is provided by cases following acute trauma, or the long-continued stresses and strains described by Sir Arbuthnot Lane.

But the disposing factor may be inherent and congenital, such as the anatomical conformation of the body and "the human constitution," which G. Draper (1924) has recently defined as "the aggregate of hereditarial characters, influenced more or less by environment, which determines the individual's reaction, successfully or unsuccessfully, to the stress of environment." Goldthwaite and Bryant described two types of departure from the normal, which they called the carnivorous, from their slender figure, and the herbivorous — broad-backed, heavy, and prone to degenerative diseases, such as arteriosclerosis, diabetes, and osteo-arthritis. The narrow-backed slender type are prone to tuberculous and other infections, many intestinal disorders, and, significant on these counts, rheumatoid arthritis. Crookshank in an able paper argues that in persons prone to become chronic arthritics there is often some morphological defect which renders a joint a place of diminished resistance. He gives examples of patients with rheumatoid joints showing definite evidence of congenital defect, such as incurved little fingers,

small thumbs, and ill formed terminal phalanges. He quotes André Léri's *pléonostéose familiare* as an extreme instance of deformity favouring subsequent disease, and Calot's observation of a congenital condition of the hip-joint, approaching dislocation, as a diagnosing factor to senile arthritis of the hip. The nervous origin of rheumatoid arthritis (Latham, 1886), ascribing the changes to disturbed trophic action, though now mainly of historic interest, may apply in a few instances—for example, in Charcot's arthropathy—by rendering the joints a *locus resistentiæ minoris.*

It must be admitted that it is often difficult to detect the infective focus; this may depend on imperfection in our means of localizing them. For example, the accessory nasal sinuses, prostate, vesiculæ seminales, or the internal female genital organs, may escape investigation; cryptic infection of submerged or apparently normal tonsils may easily be overlooked; or there may be a closed focal infection of the gall-bladder or appendix which may remain latent, not discharging their bacteria into the alimentary canal, so that bacteriological examination of the fæces may not give any clue. Another difficulty about focal infections is that the primary one, such as dental suppuration, may produce secondary foci, some of which are less easily removed—for example, in the tonsils, cervical glands, maxillary antrum, the gall-bladder, appendix, intestine, mesenteric glands (Mutch, 1915)—or one of several affected joints may act as a reservoir of infection. Mutch (1925) divides the infections of the alimentary canal into two zones—the upper, of the mouth and throat; the lower, of the bowel and its appendages; the second may be local or affect the whole, from the duodenum to the rectum. Thus extraction of the teeth may fail to relieve the joint symptoms because a secondary focus or foci have become active in distant and unsuspected parts. Thus, in a series of eighty cases of arthritis recorded by Brock, forty-two patients had had some focal infection removed, but all of them still had other foci remaining; twenty-five had lost their tonsils, and twenty-two of these still had infected teeth. One reason for the practical failure of the focal infective theory of rheumatoid arthritis is perhaps imperfect removal of the whole of the focal infection. Dentists are rightly conservative in extracting teeth they believe to be sound, but if even one tooth with latent apical infection is left this may be sufficient to keep up the joint trouble, either by serving as a continued source of bacteria conveyed by the blood, or possibly merely by providing poisons which, acting on a joint rendered hypersensitive by previous infection, responds actively. Even when teeth are removed infected roots may be left behind to keep on the evil influence; thus, among 290 edentulous jaws, M. F. Eusterman found 129 root or other evidences of infection, and he believes that 37 per cent. of the areas to which dentures are adapted harbour infection. The position is made more difficult by evidence that x-ray examination of the jaws may fail to reveal infection of the apices of the teeth (Meisser and Haden).

An objection sometimes raised to the infective origin is that the average run of rheumatoid cases show little or no evidence of corresponding systemic and visceral damage. In reply it may be said that this is also true of many cases of undoubted focal infection. But, on the other hand, rheumatoid arthritis is often associated with fibrositis and neuritis, and in the juvenile form of rheumatoid arthritis, or Still's disease, the lymphatic glands are commonly and the spleen often enlarged, and occasionally visceral lesions are found in the kidneys and in rare instances in the liver.

If for the purpose of this discussion rheumatoid arthritis be regarded as a subacute or chronic inflammation of the joints due to infection, but not proved to be due to any definite bacterial agent, so that gonococcic, pneumococcic, and other known bacterial forms of arthritis are excluded, then it appears that, logically, an arthritis of chronic course associated with streptococcic or staphylococcic invasion of the tonsils or apices of the teeth and cured after removal of the focus and corresponding vaccine treatment, should be excluded from the group of joint affections of obscure origin for convenience described as rheumatoid arthritis. In general, however, this apparently logical sequence is not observed, and such a case, presumably streptococcic, is not removed from the category of rheumatoid arthritis. There is some reason for this want of strict consistency; the streptococci form a large and even yet, from their instability, imperfectly classified group, and among the various forms some only are responsible for chronic joint

lesions. The difficulty in the specificity of the streptococci makes it reasonable to wait before transferring these cases from rheumatoid arthritis to streptococcic arthritis.

A point of interest for discussion in the clinical phenomena of rheumatoid arthritis is how far toxic influences, as apart from continuous or repeated infection of the joints, play a part. A joint is infected, and as the result of local and other treatment the condition subsides, whether the causal organisms die out or remain latent being unknown. Is it not conceivable that the joint becomes hypersensitive and, in the event of any toxin reaching it from an infective focus, such as a single tooth with apical infection, reacts in an anaphylactic manner? There are other examples of a probable anaphylactic arthritic reaction, such as intermittent hydrarthrosis and possibly gout.

Bacteriology

The infection is obviously of low virulence and of a very chronic nature. Various organisms have been found in cases of rheumatoid arthritis, which would thus appear to resemble bronchitis and colitis in being not specific but due to a number of different infections, and therefore including a number of different diseases, though clinically in many ways alike. Various streptococci are most frequently incriminated.

In 1914 Hastings found that out of a series of cases seventeen gave a positive and eighteen a negative complement fixation test of *Streptococcus viridans,* and therefore considered, what would now be regarded as a very modest estimate, that 40 per cent. of the cases of rheumatoid arthritis are infective. Among Mutch's 200 cases of intestinal infection in chronic arthritis the vast majority were streptococcic, only 6 per cent. of which were hæmolytic; from twenty-one cases examined in the course of laparotomies it appeared that the small intestine was the site of streptococcic invasion, a transition to *B. coli* infection taking place about the ileo-cæcal valve; it might thus be assumed that streptococci responsible for arthritis might not be recovered from fæces passed per anum. Beddard spoke of the long-chained organism *Streptococcus longus* as present in 75 per cent. of the cases.

Staphylococci appear to be much less often responsible than streptococci.

In 1903 Dor obtained *Staphylococcus pyogenes albus* from the joint of a rheumatoid patient. Crowe described as a causal agent *Staphylococcus epidermis albus* (variety *deformans*) or *Micrococcus deformans,* and has obtained agglutination of their own scurf cocci by their blood in patients with severe rheumatoid arthritis. Among Mutch's 200 cases 4 per cent. only were associated with staphylococci.

Other micro-organisms, such as coliform organisms, have been described.

A natural objection to the infective nature of chronic arthritis is the difficulty of obtaining micro-organisms from the joints, and even when they are obtained from chronic cases, as Poynton and Paine (1902) did, it might well be argued that the infection has supervened in a joint rendered a place of diminished resistance by the arthritic change, and that the experimental production of joint changes in animals by the injection of such an organism does not prove that the original arthritic changes in the patient were due to the organism. That the fluid removed from rheumatoid joints is almost always sterile is not surprising from analogy with the same event in tuberculous pleurisy, but the rarity with which cultivation of pieces of synovial membrane removed from such joints gives a positive result in spite of the numerous media employed is a problem deserving further investigation and consideration, if the view that rheumatoid arthritis is due to a chronic infection rather than to a toxic or metabolic factor is to be maintained.

Treatment

Treatment is primarily preventive—namely, the hygiene of the mouth and other sites of focal infection. Dental disease and oral sepsis have probably become more frequent with the more widespread consumption of soft foods, and it may be that rheumatoid arthritis has correspondingly increased; on the other hand, the school clinics for dental treatment and the removal of tonsils and adenoids are a step in the direction of preventive medicine and should exert a neutralizing effect. Removal of teeth with apical infection is obviously essential, and, as already mentioned, all affected teeth should be removed, otherwise the arthritis may continue and the result be disappointing. The patient should be warned that the extraction may be followed by a temporary aggravation of the arth-

ritis; general infection may result, and in a recent case the possibility that the preliminary injection of a local anæsthetic had favoured this complication by more widespread damage to the tissues was raised. Whether or not the affected teeth should all be removed at one sitting or extracted in relays should be decided in each case by consideration of the patient's condition and to some extent by the number of the teeth affected; leucopenia has been regarded as a sign of diminished resistance. (K. Goadby; J. A. Toren) and an indication that not more than one tooth should be removed at a time. Removal of dead teeth requires careful consideration; dead pulps favour persistence of infection and so arthritis; Izod Bennett emphasizes the responsibility in this respect of dental surgeons who kill sensitive pulps for the relief of pain. Curetting of an infected uterus is dangerous, as it may spread the infection.

Before vaccine treatment is commenced infective foci that can be dealt with, such as the teeth and tonsils, should be removed. Autogenous, not stock, vaccines should be employed, and sensitized vaccines have their advocates. When more than one organism is suspected to be responsible for the arthritis, it has been suggested that monovalent vaccines from them should be given so as to recognize the causal one by reaction in the joints; but mixed vaccines may be necessary. Vaccine therapy is often combined with, and said to be helped by, diathermy and ultra-violet radiation (Billington). Crowe's results with his *Micrococcus deformans* vaccine showed that 70 per cent. of sixty-two patients were cured for the time, and that fifteen of these or 25 per cent. of the total number, were known to remain so.

Intestinal auto-intoxication has been attacked by many disinfecting drugs, especially guaiacol. In cases with achylia gastrica hydrochloric acid by the mouth is a logical procedure in inhibiting bacterial activity in the alimentary canal, and stasis has naturally been met by purgatives—paraffin and so forth. Sulphur is an old intestinal antiseptic; intramuscular injections of sulphur in oil have been given by Reimann and Pucher, who are somewhat cautious in their estimate of the effects; and of organic sulphur compounds, contramine and thergarmine have been recommended from a different standpoint by McDonagh, who says that their effect is as striking as that of insulin in diabetes, but that their oral administration is ineffectual.

Thyroid extract and arsenic, as in so many obscure conditions, have been given, and may do good by speeding up metabolism, which Pemberton believes to be lowered as regards carbohydrates. On the other hand, parathyroid, the action of which is antagonistic, not complementary, to that of thyroid extract, has been found to be beneficial (Grove and Vines), and is said to act by correcting the disturbance of the endocrine balance between the thyroid and the parathyroid, in which the parathyroid becomes subordinate, with calcium deficiency which is due to chronic infection (Vines). The number of drugs that have been given is long; it includes iodine as a tincture or in collosol form by the mouth, or intravenously, and collosol preparations of sulphur and manganese. It has been suggested that iodine does good merely by improving the condition of the thyroid and relieving subthyroidism, which favours arthritis (Llewellyn, 1925). Pemberton, finding that there is a lowered sugar tolerance more or less in proportion to the severity of the arthritis, has employed a dietetic treatment based on restriction of carbohydrates and a reduction of the total caloric value of the food intake, with due attention to the state of general nutrition. As regards diet, Llewllyn Jones in 1909 insisted on the mistake, due to confusion with gout, of restricting meat, but in the absence of dyspepsia did not restrict the carbohydrate diet.

An important point in treatment, which the orthopædic surgeons have impressed upon us, and on which Sir Robert Jones will no doubt lay stress, is the prevention of permanent deformities from the adoption of bad positions of the limbs and trunk during the acute stages and exacerbations; as has been well said by Russell, the price paid by the patient for comfort during the acute phase is that of becoming a cripple for life. Unless carefully supervised, complete immobilization of the painful joint, by plaster or splints, may lead to troublesome fixation of the articulation.

The good effects of *heliotherapy and ultra-violet radiation,* natural or artificial, are explained in various ways—namely, by increasing the bactericidal power of the blood and so raising the resistance to infection (Rollier; Colebrook, Eidinow, and Leonard Hill), or also by

speeding up metabolism. Other forms of external treatment—by massage, heat, and hydrotherapy, such as whirlpool baths—do good by increasing the supply of blood to the joint, thus improving the local resistance and so possibly killing off the local infection, and it has been suggested that this is due to the increased oxidation processes thus favoured (Pemberton).

Protein Shock Therapy.—The intravenous injection of foreign protein in various forms, such as Witte's peptone (Auld), milk, and especially T.A.B. vaccine, so as to produce a relatively severe reaction (protein shock) has been employed with some success—at any rate for a time—in rheumatoid arthritis. Cruickshank has obtained encouraging results from the intramuscular injection of 0.3 to 0.6 gram of peptone in solution on four or five occasions at weekly intervals so as to give rise to a temperature of 101° F. Draper (1920) suggests that the good effects of the domestic remedy bees' stings in rheumatoid arthritis are due to protein shock therapy. Campbell has treated 100 cases, seventy of which, up to November, 1923, he has analyzed; of these seventy there was no improvement in twelve; in fifty-eight benefit was obtained so that forty of them were in work without relapse after periods of one to three and a half years, while sixteen, and possibly two that had been lost sight of, had relapsed. As the infection may be inhibited only and not abolished by protein shock therapy, he suggests that it may be wise to give one or two more injections after the active phase has disappeared.

Questions for Discussion

The following points may be suggested for discussion:

1.—Is rheumatoid arthritis always infective in origin?

2.—What is the relation of tuberculosis elsewhere to chronic arthritis?

3.—What share do constitution and disorders of metabolism take in its causation?

4.—Are the arthritic and endocrine disorders both due to infection, or does metabolic disorder sometimes precede and dispose to infective arthritis?

5.—Treatment by endocrine therapy, dietetic modifications, and protein shock?

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